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CHEMICAL SAFETY HANDBOOK

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Ontario

Ministry
of the
Environment

The Honourable
George A. Kerr, Q.C.,
Minister

K.H. Sharpe,
Deputy Minister

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CHEMICAL SAFETY HANDBOOK

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PESTICIDES CONTROL SECTION

POLLUTION CONTROL BRANCH

ONTARIO MINISTRY OF THE ENVIRONMENT

REVISED DECEMBER, 1977

ACKNOWLEDGEMENT

We wish to acknowledge and thank Information Canada and Health and Welfare Canada for the right to use sections from their publication, "Handbook on Chemical Safety in the Aerial Application of Chemical Material."

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EMERGENCY ACTION

MAJOR CRASH OR SPILL

If intoxication occurs due to direct contact with the pesticide:

- STEP 1: Move the patient well away from any contaminated area and from the vicinity of pesticides. Quickly remove any contaminated clothing. Wash exposed area with soap and water.
- STEP 2: Start the first-aid treatment immediately (see page #3).
- STEP 3: Call a physician as quickly as possible (but do not abandon the first-aid treatment).
- STEP 4: Keep the patient as quiet as possible and complete the first-aid treatment. Keep the patient warm and comfortable.
- STEP 5: If there is respiratory weakness, or if breathing ceases, give artificial respiration immediately.
- STEP 6: If the symptoms are of a moderate or severe case of organophosphate or carbamate poisoning, and the patient is conscious, two atropine tablets (1/100 grain each) should be administered by a medical doctor or under his supervision.
- STEP 7: If medical help cannot be obtained or is delayed, transport the patient to the nearest hospital, physician's office, or poison control centre. Take the pesticide label or the container or any available records of pesticides used; and any other information, such as the notes in this handbook. See page 47 for a list of poison control centres in Ontario.

ADVISE ATTENDING PHYSICIAN IF ATROPINE HAS BEEN ADMINISTERED.

NEVER GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS PERSON.

If intoxication due to continued exposure to the pesticide is at any time suspected:

- STEP 1: If the symptoms are more than minor irritation, call a physician immediately.
- STEP 2: Keep the patient as quiet as possible.
- STEP 3: If there is evidence of respiratory weakness, give artificial respiration.
- STEP 4: If unconsciousness or convulsions occur, apply first-aid procedures.

- STEP 5: If it is known that the symptoms are due to over-exposure to an organophosphate or carbamate pesticide, and the symptoms are severe but the patient is conscious and has adequate respiration, 2 atropine tablets (1/100 grain each) should be administered by a medical doctor or under his supervision.
- STEP 6: If medical help cannot be obtained, transport the patient to the nearest hospital, physician's office, or poison control centre. Take any available records or labels of pesticides used; and any other information, such as the notes to the medical profession included in this handbook.

ADVISE ATTENDING PHYSICIAN IF ATROPINE HAS BEEN ADMINISTERED.

NEVER GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS PERSON.

GENERAL SYMPTOMS

In general, the symptoms which indicate that pesticides poisoning has occurred are as follows:

MILD POISONING

(Note that mild symptoms may be the beginning of a progression to severe symptoms):

headache, fatigue, skin irritation, loss of appetite, dizziness, weakness, nervousness, nausea, perspiration, diarrhea, eye irritation, insomnia, thirst, restlessness, irritation of nose and throat, loss of weight, soreness of joints, changes of mood.

MODERATE POISONING

(Note that moderate symptoms may be the beginning of severe symptoms):

nausea, trembling, muscular incoordination, excessive saliva, blurring of vision, feeling of constriction in the throat and chest, difficulty in breathing, flushed or yellow skin, abdominal cramps, vomiting, diarrhea, mental confusion, twitching of muscles, weeping, excessive perspiration, profound weakness, rapid pulse, cough.

SEVERE POISONING

vomiting, loss of reflexes, inability to breathe, uncontrollable muscular twitching, constriction of pupils (to pin-point pupils), convulsions, unconsciousness, severe secretion from respiratory tract, fever, thirst, increased rate of breathing.

FIRST-AID TREATMENT

MOVE WELL AWAY FROM ANY PESTICIDE:

1. Quickly move the patient to safe uncontaminated surroundings, and remove any contaminated clothing.

IF BREATHING IS VERY WEAK OR HAS CEASED:

1. Give artificial respiration.
2. Oxygen can be beneficial.

IF PESTICIDE HAS BEEN SWALLOWED:

DO NOT induce vomiting if the pesticide solvent is a petroleum distillate, such as fuel oil or kerosene.

1. If the patient has not vomited, induce vomiting immediately. Do this by introducing a finger into the throat, or by giving warm salt water (two tablespoons of salt in a glass of warm water).
2. Give milk or cold water freely.
3. Again induce vomiting if vomit fluid is not clear.

DO NOT GIVE ANYTHING BY MOUTH TO A PERSON WHO IS UNCONSCIOUS, OR HAVING CONVULSIONS.

IF PESTICIDE IS SPLASHED IN THE EYE:

1. Wash the eye with clean water, immediately.
2. Use large amounts of clean water to gently irrigate the eye.
3. Continue for at least 15 minutes.
4. Boracic acid solution may be beneficial.

IF PESTICIDE IS SPILLED ON THE SKIN:

1. Remove all contaminated clothing. Cover the patient with clean clothing or a clean blanket.
2. Wash the skin thoroughly with plenty of soap and water, immediately, and repeat again.
3. Clean under finger and toe nails.
4. Wash contaminated skin with rubbing alcohol.

IF RESPIRATION BECOMES WEAK OR IRREGULAR:

1. Give artificial respiration.
Maintain breathing and prevent worsening of condition.
2. Oxygen can be beneficial.

ARTIFICIAL RESPIRATION TAKES PRECEDENCE OVER ALL OTHER FIRST AID.

IF CONVULSIONS OCCUR:

1. Keep warm. Keep dry.
2. Prevent injury. Use gentle restraint.

IF UNCONSCIOUSNESS OCCURS:

1. Ensure patient can breathe adequately (may need to pull tongue forward to prevent blocking the throat).
2. Keep patient warm and dry.
3. DO NOT GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS PERSON.

IF PESTICIDE IS AN ORGANOPHOSPHATE OR CARBAMATE AND THE SYMPTOMS ARE SEVERE:

1. Two atropine tablets of 1/100 grain or 0.6 mg each should be administered by a medical doctor or under his supervision.
2. BUT DO NOT give atropine if the patient is already turning blue because of inadequate respiration, or to an unconscious patient.

IF YOU KNOW THE TYPE OF PESTICIDE:

1. Check the appropriate pesticide group for additional first-aid treatment and information.

OBTAIN MEDICAL ATTENTION AS QUICKLY AS POSSIBLE.

ADVISE ATTENDING PHYSICIAN IF ATROPINE HAS BEEN ADMINISTERED.

CHEMICAL SAFETY

Pesticides application is a very serious business. They can cause illness; and they can kill. The great usefulness of pesticides rests on their ability to interrupt the life processes of insects, fungi, or plants. But many of these toxic chemicals can have dangerous effects on humans and other animals. All should be handled with great respect.

Knowledge is the key. Every person who clearly understands the hazards associated with pesticides will have the incentive to run a "clean" operation.

Each person who is involved in the handling and distribution of pesticides must be vigorously and repeatedly impressed with the seriousness of allowing even a tiny amount of these chemicals to be taken into the body by breathing, swallowing, or absorption through the skin. It is wise to assume that all pesticides may be absorbed through any one of these three routes, and protective measures need to be strictly adhered to with this very much in mind.

Adequate knowledge and rigid application of safe practices are fundamental to the protection of operating personnel, the public, and

the environment.

Furthermore, in every instance of pesticide application, someone has to assume responsibility for the conduct of the operations. This management function is important, and should ensure that:

- (a) the least toxic but most effective pesticide is used;
- (b) that application is at the minimum effective rate, and all on the target area;
- (c) application equipment is regularly maintained and calibrated;
- (d) all personnel (including very temporary personnel) are fully briefed on safe procedures, and are properly supervised and protected.
- (e) liaison is pre-arranged with local medical facilities;
- (f) personnel receive regular physical examination, including blood cholinesterase determinations, if necessary.

A person should never be allowed to work alone under conditions in which he could not receive prompt help in the case of an accident. Arrangements should be made so that if a poisoning occurs it is possible immediately to:

- (1) decontaminate the individual, and
- (2) deliver him to emergency treatment facilities.

Arrangements for prompt treatment should be made in advance.

Experience has shown that if proper precautionary measures are observed, even the most toxic compounds can be used safely. Instruction of personnel who handle pesticide chemicals is the most effective way to reduce hazards. It is fundamental that workers at all levels of responsibility be thoroughly briefed in good practice. This means that every person must be fully aware of the properties of the chemicals in use, of proper storage and handling procedures, and of the means for dealing with any emergencies.

It is recommended that copies of the following page should be prominently displayed in every work area, aircraft, truck, storage area, eating area, and washroom.

TWELVE RULES FOR CHEMICAL SAFETY

- 1. Inspect pesticide containers for leaks before handling them.
- 2. Do not handle containers roughly or carelessly.
- 3. Should a leak or spill occur, keep people and animals away from the area; decontaminate thoroughly and report immediately to

the Supervisor of the Pesticides Control Section, Ministry of the Environment, 135 St. Clair Avenue West, Toronto M4V 1P5
Telephone: (416) 965-2401.

4. Inspect vehicles for contamination after unloading; do not permit a contaminated vehicle to leave.
5. Do not store pesticides or empty pesticide containers anywhere near food or drink (including that for animals).
6. Do not keep food, drink, tobacco, cups, or cutlery anywhere in the work areas or in work clothes.
7. Do not eat, drink, or smoke in a work area.
8. Do not rub the eyes or touch the mouth while working with pesticides.
9. Wash hands thoroughly before eating, drinking, smoking, or using the toilet.
10. Wear clean rubber gloves and protective clothing when handling pesticides, and a respirator whenever recommended.
11. Never fail to discard contaminated clothing or faulty protective covering, especially gloves.
12. Read the label carefully; if seeking medical aid, take the label and/or the container with you.

CHEMICALS AND FORMULATIONS

Chemicals used for the control of insects, weeds, and plant diseases are biologically active compounds. A wide variety of these chemical compounds - generally known as "pesticides" - is available, and a clear understanding of the distinctions between them is essential to proper management.

In order to help clarify and manage a vast amount of information, three classifications are employed, namely: (1) by purpose, (2) by formulation, and (3) by chemical composition. All three need to be described for any one case. Item (3) is the active ingredient and may be given either as the chemical name or a trade name. Item (1) may also be descriptive of the mode of action of the chemical.

It is necessary to use these three joint classifications in order to maintain a clear understanding of complex subject matter, and thus the correct utilization of control chemicals.

CLASSIFICATION BY PURPOSE

The broad division of "pests" into insects, weeds, and fungi naturally evolves the terms (a) insecticides, (b) herbicides, and

(c) fungicides.

INSECTICIDES

The chemical compounds used to control insects are sub-divided in accordance with their mode of action:

A - CONTACT INSECTICIDES

These are insecticides which kill primarily through direct contact with the insect. The chemical has the property of being absorbed through the external body surfaces of the insect in sufficient quantity to be lethal.

B - RESIDUAL INSECTICIDES

These insecticides act primarily by the insect subsequently taking up the dose from a leaf or other treated surface.

C - STOMACH POISONS

Stomach poisons are insecticides which must be eaten by the insect in order to be effective. External contact is not sufficient.

D - SYSTEMIC INSECTICIDES

These insecticides are compounds which, when applied to plants or animals, are absorbed by and flow through the system of that plant or animal in sufficient quantity to protect it against the insect (at points remote from the point of application).

E - FUMIGANTS

Fumigants may be insecticides which vaporize and effect control by contacting the insect in the vapour form.

Since insect development progresses through several distinct stages during the life cycle, different insecticides may be needed to attack each stage. Thus, insecticides may also be classified according to the particular insect stage on which they are most effective:

1. ADULTICIDES: are most effective against the adult form of the insect.
2. LARVICIDES: are most effective against the grub, worm, or larva of insects.
3. OVICIDES: are most effective against the egg stage of insects.

In addition, some insecticides may be specifically referred to in accordance with the particular type of insect they are capable of controlling, such as aphicides for the control of aphids, and acaricides for the control of spider mites.

HERBICIDES

These chemical compounds used to kill or inhibit undesirable plant growth may be sub-divided in accordance with their selectivity and mode of action:

A - CONTACT HERBICIDES

Contact herbicides are those that kill primarily by contact with plant tissue, rather than as a result of translocation. Only that portion of the plant contacted is directly affected, and the effect is usually rapid. Complete coverage is necessary for complete control.

B - SYSTEMIC OR TRANSLOCATED HERBICIDES

Systemic or translocated herbicides act more slowly, taking perhaps several weeks for maximum effect, and are capable of movement within the plant away from the site of application.

C - GROWTH REGULATORS

Growth regulators alter the growth characteristics of plants. Careful timing and application are necessary.

Herbicide treatments are either:

NON-SELECTIVE: to kill or suppress all vegetation in the treatment area.

SELECTIVE: to kill or suppress some plants without affecting others.

SELECTIVE HERBICIDES may also be classified according to the time of application, as follows:

1. PRE-PLANT HERBICIDES

These are applied to the soil before seeding of the crop. (Some types must be incorporated into the soil after application).

2. PRE-EMERGENT HERBICIDES

Pre-emergent herbicides may be applied following seeding of the crop, pre-emergent to the crop only, or pre-emergent to both crop and weeds.

3. POST-EMERGENT HERBICIDES

These are applied following emergence of the crop, or weeds, or both.

FUNGICIDES

Fungicides are chemicals which control the causes of many plant diseases. There are two main types, as follows:

A. PROTECTIVE FUNGICIDES

Protective fungicides are applied before the invasion of the disease begins, and will destroy any spores as they germinate.

B. IRRADICANT FUNGICIDES

Irradicant fungicides will control fungi already established in the host plant.

Most fungicides are contact materials, or have very limited systemic action. Thus, as is in the case with contact herbicides, you must get complete coverage.

CLASSIFICATION BY FORMULATION

Biologically active chemicals need to be put into a form in which they may be dispersed evenly at the required rate; in other words, they need to be formulated. The common formulations are solutions, emulsions, suspensions, dusts, and granules. Some chemical compounds may be adapted to all formulations; others may be limited by their physical properties to only one or two.

The type of formulation will to a great extent govern the total volume of material which has to be distributed in order to evenly disperse the active chemical ingredient at the required rate per unit area. Thus the choice of high-, medium-, or low-volume application is dependent upon the formulation.

The least volume of material would obviously be required to be distributed if the active ingredient (also referred to as the "technical material") were not formulated (i.e., diluted) at all. Such a method is now available and is known as the ultra-low volume-technique (ULV).

This method requires equipment which will evenly distribute with very small quantities (2 to 16 oz.) of liquid per acre. With this equipment, any insecticide which is itself a liquid may be applied undiluted or as a very highly concentrated solution. Owing to limited information on effectiveness, toxicity, and drift hazards, only a few insecticides are currently registered for ULV application.

Unless the chemical is registered for ULV application, and the appropriate equipment is employed, a formulation of the technical material (and therefore a greater volume) must be used. The available formulations are as follows:

A. SOLUTIONS

When a chemical compound (dry or liquid) is dissolved in a liquid, the result is a solution. Such a solution may be in water, or in an organic solvent. Most pesticides are relatively insoluble in water, and must be dissolved in an organic solvent before being added to the water.

B. EMULSIONS (FROM EMULSIFIABLE CONCENTRATES)

Oil solutions which are intended to be diluted with water are formulated as a concentrate, with emulsifying agents added to permit the oily product to disperse in water to form an emulsion. This gives the thin, milky liquid which is characteristic of an emulsion by which the oil-carried pesticide is dispersed through the water diluent.

C. INVERT EMULSIONS (FROM EMULSIFIABLE CONCENTRATE)

In this case a water solution is formulated as a concentrate and dispersed in oil to form an emulsion; that is, the water-carried pesticide is dispersed through an oil diluent. This results in a thick mayonnaise-like mixture, which is used when drift control is of prime importance.

D. WETTABLE POWDERS

Wettable powders are formulated by mixing the active ingredient into a clay-like powder, together with special wetting agents. When mixed with water ready for use, the result is a suspension; which usually requires constant agitation to maintain a uniform mixture.

E. DUSTS

Dusts consist of clay-like materials to which have been added appropriate amounts of active ingredient, and thoroughly mixed. Dusts are intended to be used exactly as supplied, without further dilution or mixing.

F. GRANULES

Granules are formulated by mixing the active ingredient with a clay-like material, in a process which yields relatively large particles or granules carrying the required level of pesticide. Granules are used to facilitate placement of the active ingredient, and can be especially prepared to suit particular circumstances.

NOTE: ADDITIVES

Additives or adjuvants of various kinds are available to modify or improve the properties of the spray liquid according to need, particularly in the case of solutions. Spreader-stickers are additives which will help the spreading and adhesive properties of the spray solution. Thickening or foaming agents may be added to a spray solution to produce a viscosity that is useful in reducing the number of fine particles in the spray cloud. Several varieties of these adjuvants are available.

CLASSIFICATION BY CHEMICAL COMPOSITION

Biologically active chemical compounds for pest control may be initially classified into two main groups:

A. INORGANIC COMPOUNDS

Inorganic compounds do not contain carbon and are usually derived from mineral ores, extracted from the earth. The most common compounds used today are derivatives of copper, zinc, sulphur, phosphorous; i.e., copper sulphate, zinc phosphide, aluminum phosphide.

B. ORGANIC COMPOUNDS

Organic compounds contain carbon atoms in their chemical structure. They are mostly synthesized from basic chemicals but some are extracted from plants and these are called "botanicals" or natural products. These organic compounds can be divided into various groups or families of

chemicals. Each group contains chemical compounds which have some common characteristics, and one group may contain insecticides, herbicides and fungicides. The following are some of the major organic chemical groups:

GROUP 1 ORGANOCHLORINE COMPOUNDS (CHLORINATED HYDROCARBONS)

All pesticides in this group contain chlorine, carbon, and hydrogen; some also contain oxygen and sulphur. Most chlorinated hydrocarbons are insecticides. In general, these compounds have relatively high persistence in soil, food and feed, and tend to accumulate in the fatty tissues of man and animals. The most common members of this family are DDT, aldrin, dieldrin, chlordane, endrin, lindane, BHC, heptachlor, methoxychlor, toxaphene, endosulfan, and perthane.

GROUP 2 ORGANOPHOSPHORUS COMPOUNDS

The organophosphate compounds are derivatives of phosphoric acid. They contain phosphorus, carbon, and hydrogen; some also contain sulphur and oxygen. With a few notable exceptions, the group is acutely toxic, and all act as cholinesterase depressants. Most of the group are insecticides, and some of them are acaricides also. This group is less persistent in soil, food and feed for animals; many are combustible. Common members of the family are parathion, phorate, azinphos-methyl, dimethoate, fenitrothion, fenthion, malathion, diazinon, abate, phosphamidon, Phosdrin, TEPP.

GROUP 3 CARBAMATE COMPOUNDS

This family of compounds is typified by a particular arrangement of nitrogen, carbon, and oxygen in the chemical structure. Members of the group are: insecticides - carbaryl, arprocarb, lannate; herbicides - propham, triallate, barban, Eptam; fungicides - maneb, nabam, zineb.

The chemicals of this group are, in general, less persistent in the environment. The toxic hazard to humans and animals is mild with the above herbicides and fungicides, but the insecticides have a greater toxicity.

GROUP 4 CHLOROPHENOXY COMPOUNDS

The chemical structure of this family is characterized by a phenol ring to which is attached a number of chlorine atoms and a variety of organic acids. Virtually all are herbicides, and members of this group are among the most widely used herbicides due to their value in weeding grain crops. They are selective in that grasses (as well as a few other crop species) are physiologically resistant to them. The most common members of the group are 2,4-D, MCPB, 2,4,5-T, and MCPA: all have low to moderate toxicity to humans and animals. Some formulations are sufficiently volatile to cause a risk of damage due to vapour drift.

GROUP 5 DINITROPHENOL COMPOUNDS

Dinitrophenols derive their name from a phenol ring to which are attached nitrogen-oxygen radicals. Belonging to a family of dye chemicals, they are a strong yellow in colour, and stain any organic material with which they come in contact. This group is considered to be quite toxic, and may be employed as herbicides, insecticides, and crop desiccants. The most common member of the group is dinoseb.

GROUP 6 SUBSTITUTED UREAS

This group of herbicides is mildly toxic to humans and includes fenuron, monuron, and diuron. The earliest compounds in this group were non-selective, long-term residual weed killers, usually applied to the soil. More recently developed compounds, such as linuron and chloroxuron, are more selective and may be applied postemergent to the crop.

GROUP 7 TRIAZINES

The chemical compounds in this group are all herbicides of mild toxicity to humans and include atrazine, simazine, propazine, prometon, prometryne, desmetryne, and amitrole. They all appear to affect photosynthesis following uptake by the root system, and those with a higher water solubility may also enter through the foliage. Residues from these compounds are noted for their persistence in the soil.

GROUP 8 BOTANICALS

This group is so-named because they are derived from plant materials rather than from synthesized chemicals. Members of the group include pyrethrins, rotenone (derris), ryania, and nicotine. Toxicity to humans and animals ranges from very low for pyrethrins, to very high for nicotine sulphate.

GROUP 9 GUANIDINES AND NAPHTHOQUINONES

This group has low toxicity to humans and includes dodine and dichlone; both are fungicides.

GROUP 10 TRICHLOROBENZOIC, TRICHLOROACETATE, AND TRICHLOROPICOLINIC

This group is relatively non-toxic to humans and includes TBA, TCA, and picloram. However, TCA will cause burns from prolonged skin contact, and picloram is combustible. All are herbicides with long soil residue properties.

GROUP 11 CYCLOHEXENES, PHTHALIMIDES, AND PROPIONICS

This group includes captan and folpet (fungicides) and dalapon (herbicide). All are mildly toxic to humans.

GROUP 12 PYRIDYLIUM

This group are herbicides and include diquat and paraquat. Both diquat and paraquat are liquid herbicides absorbed through the leaves and are capable of the rapid removal of foliage; they should be considered very toxic to humans.

GROUP 13 HYDROPHTHALIC

This group is very toxic to humans and includes endothall, a herbicide mainly used for aquatic weed control.

REGISTRATION

The only pesticides which may be offered for sale are those which have been registered under the authority of the Pest Control Products Act, which is administered by Agriculture Canada.

Each pesticide container must bear the registration number as part of its accepted label. The label must include the brand and name of the chemical, the product's chemical composition and form, the net contents, precautionary measures, and guarantee.

The label for each pesticide on the market must bear precautionary statements relative to toxicity. For very toxic poisons, the label includes the handling precautions, diagnostic symptoms of poisoning, and first-aid measures. It should be carefully studied before use of the product. Pesticide accidents are often due to ignoring the label warnings.

READ, AND KEEP THE LABEL INTACT AND IN GOOD CONDITION.

NOTE THE FOLLOWING INFORMATION ON THE LABEL:

- (1) the chemical group and chemical name of the pesticide, as well as the trade name.
- (2) its toxicity and hazard rating; and poison symbols, as follows:

DANGER



POISON

WARNING



POISON

CAUTION



POISON

- (3) the concentration of the active ingredient in the product;
- (4) the protective measures to be taken, including the correct type of respirator if required;
- (5) the recommended uses and rates of application;
- (6) the correct handling, mixing, and loading procedures;
- (7) the first-aid treatment.

If you do not have this information, do not use the pesticide.

If you do have this information, then ensure the availability of medical supervision before proceeding.

TOXICITY

Since most chemical pesticides have some degree of toxicity to man, everyone who works in pest control should be aware of the potential hazards which accompany their use.

Many pest control compounds are two-edged swords; because they are not selectively toxic only to the intended victims, and are highly poisonous to humans and animals.

Prevention of overexposure is undoubtedly the best insurance against poisoning. The most potent pesticides may be safely handled if enlightened and disciplined adherence to good practices is ensured.

HAZARDS

The majority of herbicides are less toxic than insecticides. The major risk is to sensitive crops in adjacent areas, and thus drift of herbicide sprays has to be avoided. Spray tanks must be thoroughly cleaned of herbicide formulations before they are used for other pest control purposes.

The insecticides constitute the main hazard to men and animals. In general, the organophosphate insecticides are more toxic than the carbamates or chlorinated hydrocarbon compounds. The effects of carbamate exposure tend to be more rapid but less severe and not so long-lasting as those which follow organophosphate intoxication. The hazard with chlorinated hydrocarbons is usually low at the time of application, but these compounds are much more stable and may have long-term side-effects through contamination of the food chain. Thus, consideration must be given to the possible accumulation of harmful residues. Care must be taken that insecticides do not contaminate bodies of water.

Some of the organophorus insecticides, (e.g., parathion) are highly toxic and, in addition to special protection for the operator,

care must be taken that the spray does not reach animals, birds or humans at the time of application. Sprayed fields should not be entered for some time.

Not only do pesticides vary widely in their toxicity, but it is also important to note that some have only an acute toxicity, some are only chronic in nature, and some have both acute and chronic effects. It is also known that toxicity may vary with the type of formulation used, with the route of absorption into the body, and with the body weight. The susceptibility of humans to poisoning by a pesticide will also differ with age, sex, and nutritional state.

LETHAL DOSE 50% (LD_{50})

The accepted method of recording the relative toxicity of a pesticide is the Lethal Dose 50% (LD_{50}) value. This is a statistical estimate of a chemical dose which, when administered, will kill 50% of the test animals under stated conditions. This is the accepted yardstick used to denote hazard, but care must be exercised in its interpretation.

The figures which designate the LD_{50} values are expressed in milligrams of dose per kilogram of body weight of the test animal. The chemical dose to kill a 2000 pound horse will be about 10 times the same relative dose for a 200 pound foal. (The LD_{50} 's will be approximately the same for the foal and the horse). For any one group of test animals of the same species, therefore, the weight of each animal has to be determined.

The test animal may be a rat, dog, bird, or fish, but very rarely is LD_{50} information available for humans. The LD_{50} values are seriously affected by the age of the test animals and strains of the same species may react very differently to the same treatment. For this reason, the LD_{50} values developed for one species only begin to inspire confidence after numerous tests have been conducted by many workers under varying conditions. It is because pesticides are selective in their action, and therefore different species of animal life react differently to such a degree, that the compounds are useful. Thus, the LD_{50} values for rats or dogs may have little bearing on the value for birds or humans. Nevertheless, LD_{50} values are very useful in classifying pesticide chemicals according to their toxicity, so long as it is recognized that the values are not absolute and should be expressed as a range.

Toxicity also varies with the route of absorption into the body. LD_{50} values may therefore be determined for different routes of administration; the oral, dermal, and respiratory routes being of most practical significance.

Another way of expressing relative toxicity is employed in the case of fish (and may also be used with birds and wildlife of low body weight). This is the Lethal Concentration 50% (LC_{50}) value expressed as parts per million (ppm). In the case of fish, this value is the ppm of chemical (active ingredient) in the water for a certain period of time (usually 24 hours) which will kill 50%.

Also, an LC_{50} value in air is used in connection with the poisoning of mammals by inhalation.

In all cases, the higher the value given for LD₅₀ or LC₅₀, the less toxic the material.

TOXICITY OF SOLVENTS

Some solvents and adjuvants are themselves toxic; skin irritation, in particular, may be due to the solvent and not the pesticide. Some adjuvants are highly toxic and must be stored and handled with the same care as the technical material.

TOXICITY TO HUMANS

Should an accident occur in which someone is doused with a pesticide and almost immediately goes into a coma, then there is no doubt about the cause of the illness and proper treatment can be administered. A more insidious problem occurs with mild, slow poisoning over a period of time: the symptoms are less severe and frequently difficult to distinguish from the results of the normal stresses of life.

Thus chronic toxicity is just as important as acute toxicity.

Furthermore, the greatest risk to operators engaged in the application of pesticides occurs if an episode of acute poisoning (due to a spill or lack of protective gloves, for instance) is superimposed upon a condition of chronic poisoning.

MEANS OF ABSORPTION

(1) Oral

The mouth and alimentary canal is one route by which a pesticide can be absorbed. Such poisoning may occur because of an accident, but is more frequently due to inexcusable carelessness. The blowing out of plugged nozzles, smoking or eating without washing, or the contamination of food or cutlery, are common examples of this. Good hygienic practices and frequent washing are always essential when handling or applying pesticides.

(2) Dermal

The most common risk of absorption of a pesticide is through the skin. Skin contamination can occur easily, and is often not detected until symptoms have developed. It is important to remove the pesticide from the skin as quickly as possible. The danger of skin absorption is always greatest when the temperature is high and the skin is wet with perspiration. Dermatitis may also increase the risk of absorption. In general, the organophosphorus compounds penetrate the skin much faster than do the chlorinated hydrocarbons.

(3) Inhalation

Absorption through respiration is an important route when sprays or dusts are actually being applied. It can also occur where mixing is being done in confined areas; therefore, the preparation of formulations inside buildings should be avoided.

A particular danger exists with highly toxic substances which vaporize readily, such as parathion, TEPP, aluminum phosphide (Phostoxin), methyl bromide, and cyanide compounds.

PRECAUTIONS TO BE TAKEN

Sensible and practical precautions to avoid unnecessary exposure should always be followed. Good personal cleanliness should always be maintained. It should be anticipated that accidents from broken hose connections, spillage or dripping nozzles etc., can and will occur; provision must be made for the immediate change of contaminated clothing and thorough washing.

RELATIVE TOXICITY

The LD₅₀ values quoted are based on the active ingredient and not on the formulated product nor the spray-tank mixture. The formulating and proper tank mixing reduces the toxicity of these chemicals considerably.

A comparative classification of hazard and corresponding probable lethal dose values of technical material for a 150 lb. (70 kg.) human adult is as follows:

LD ₅₀ VALUE	HAZARD RATING	
0-50	High	Less than 1 tsp.
50-500	Medium	up to 1 ounce
500-2500	Low	up to ½ pint
2500	Very Low	up to 1 pint

The acute oral LD₅₀ values for some common drugs and materials are as follows, and may be compared with the values given above for pesticides:

CHEMICAL	ORAL LD ₅₀ VALUES
aspirin	1750
Gravol	500
strychnine	20
amphetamine	5
ethylene glycol (anti-freeze)	3500
phenobarbitol	660
ethyl alcohol	13700
common salt	3300

Each group of chemical compounds has its characteristic set of effects on humans. The organophosphates and carbamates are similar in many respects, but the chlorinated hydrocarbons are quite different in that they are cumulative in the body tissue.

ORGANOCHLORINES

Pesticides in the chlorinated hydrocarbon group have little or no obvious effect when dosages are light, even when exposure to them is continuous, but can build up in the fatty tissue, and may thus pose a serious cumulative problem. Therefore, the chronic toxicity, and hence the dosage, duration, and frequency of exposure, is most important in the case of the chlorinated hydrocarbons. Since these symptoms are similar to those induced by many other poisons, a detailed study may be required to ascertain whether a member of this group is responsible.

The organochlorines act generally to unstabilize the central nervous system, but the exact mechanism of this action is not known. Repeated dosages may induce microscopic changes in the liver and kidneys. Although many of these insecticides, or their degradation products, can become stored in the body fat, they are apparently without adverse effect so long as they remain in the fat. But if released as a consequence of fat depletion, they can constitute a source of poisoning, giving symptoms similar to those following a heavy exposure. Loss of weight is therefore a serious matter. Deposits in the body fat otherwise disappear only after a long period of time, when further exposure has ceased.

ORGANOPHOSPHATES AND CARBAMATES

The organophosphate and carbamate pesticides do not become stored in body fat; thus mild exposures at infrequent intervals usually do not result in cumulative effects within the body. Nevertheless, there is always a danger from repeated small exposures to these types of pesticide, which may lower the acetyl cholinesterase level without producing serious symptoms, or even any symptoms at all. This is believed to be a frequent cause of accidents.

In general, the organophosphorus and carbamate compounds result in acute toxic reactions. Once the patient has been removed from further exposure to the compound, recovery is usually rapid; there are usually no serious after-effects, provided that renewed exposure is avoided. Both the organophosphate and the carbamate compounds inhibit the enzyme acetyl cholinesterase in the nervous system, but the carbamates generally present less serious problems than the organophosphates.

The rate at which the cholinesterase level is depressed is important if it occurs suddenly as a result of the rapid absorption of small doses of the toxicant. A sudden marked depression resulting from larger doses can lead to a critical condition.

CHOLINESTERASE LEVEL

When a signal goes from the brain to initiate movement of a muscle, it must pass through a number of nerve junctions. At each junction, a chemical mediator is released at one nerve ending to stimulate the next nerve, and then is quickly destroyed so that its action does not persist. This mediator is acetylcholine and, immediately after discharge, it is broken down into acetyl and choline

components. The compound that accomplishes this breakdown is an enzyme known as acetyl cholinesterase.

The term cholinesterase refers to a number of enzymes that have the ability to split, or hydrolize, esters of choline. Acetyl choline is an important chemical mediator and is found through the central nervous system, at various junctions in the nervous system, and also at many nerve terminations in various glands and muscles through the body (such as in the eyes, in the gastrointestinal tract, and in the lungs). Normally, acetyl choline is rapidly destroyed by acetyl cholinesterase as soon as it has accomplished its task. More acetyl choline is formed as needed for the next nerve impulses. Acetyl choline and the cholinesterase enzymes are in a delicate state of balance, interacting to modulate the complex nervous system in controlling body functions.

But if the acetyl cholinesterase is not functioning, the acetyl choline builds up and the system is in trouble.

The cholinesterase can be inactivated by organophosphate or carbamate poisoning. The symptoms which then occur are all due to the fact that, as a result, nerve impulse transmission races out of control because of the buildup of acetyl choline at the ends of nerve fibers. A variety of clinical signs and symptoms results, depending on the severity of poisoning and the system which is most affected.

However, the cholinesterase level may also be decreased in other types of tissue and in the blood serum, which therefore can be used as an index of poisoning. (The level in the blood can be lowered considerably without seriously affecting normal functions). At least two types of cholinesterase exist in the body. That which splits only acetyl choline is also found on the surface of red blood cells, and is known as "red cell cholinesterase." Another type which splits other choline compounds as well is known as "plasma cholinesterase." The activity of both enzyme types can be measured accurately with suitable laboratory procedures. Exposure to organophosphate or carbamate pesticides can thus be estimated by measurement of cholinesterase activity in the blood.

The blood cholinesterase test is of value in two ways. Firstly, it is extremely valuable and reliable in diagnosing cases of poisoning by organophosphate or carbamate compounds. Secondly, regular tests are of value in monitoring the cholinesterase level of personnel using organophosphate or carbamate pesticides, and thus warning of impending intoxication. Such testing forestalls illness in a worker who is unduly exposed day by day and gradually approaches a state of clinical poisoning.

However, routine blood cholinesterase tests should not be relied upon as ensuring complete safety or overlooking the need for absolutely safe procedures. The test cannot (as yet) be carried out daily and therefore cannot provide the day-to-day protection of personnel.

An additional advantage of a routine testing schedule, say every ten days, of personnel regularly exposed to organophosphate or carbamate

pesticides is that it is possible to identify those individuals or steps in the procedures that represent weak spots in the safety programme.

In order to be able to use the blood cholinesterase test (either in an emergency or on a routine check basis), it is essential to have the normal pre-season level of each person determined. Only then is it possible to know if the level has become depressed. There is no standard level of cholinesterase; it varies very widely among different people. The normal level for each individual must be known at the beginning of the season.

A low cholinesterase reading may not necessarily be due to exposure to a pesticide, but critical poisoning in man is always accompanied by a drastic reduction in cholinesterase levels; and in every case, the normal level, the exposure history, the symptoms and the clinical findings have to be taken into consideration.

In the absence of additional absorption or of medical treatment, the cholinesterase enzymes regenerate slowly. Red cell cholinesterase usually requires about 120 days to return from very low to normal values, while plasma cholinesterase (which is manufactured by the liver) returns to normal in about 30 days. If additional exposure to organophosphates or carbamates occurs during the "recovery" period, the further inhibition of the enzymes will prolong the regeneration to normal levels. This has important implications for workers who may sustain a series of exposures during the season.

Because, in general, a carbamate - cholinesterase combination is less stable than organophosphate - cholinesterase, the effects of carbamate exposure tend to be not so long-lasting as the symptoms that follow organophosphate intoxication. With some carbamates, the cholinesterase level returns towards normal very quickly and, because of the short duration of the depression, a blood cholinesterase test may be of little value as an indication of poisoning, unless taken immediately. For further information, please contact the staff of the Pesticides Control Section, Ontario Ministry of the Environment.

TOXICITY TO FISH AND WILDLIFE

Pesticides which are potentially hazardous to fish and wildlife can cause serious effects if improperly applied. If the application of pesticides results in losses to non-target fish or wildlife, the Ministry of the Environment must be notified immediately. A list of telephone numbers that you can contact are attached. Prompt reporting can bring about an immediate investigation of damage and any remedial action possible. The Ministry of Natural Resources and the Ministry of Health should also be informed.

PRECAUTIONS TO BE TAKEN

The following precautions must be taken by every applicator to ensure that his actions are not contributing to any effects on fish and wildlife:

- (1) Do not exceed prescribed application rate.

- (2) Do not apply pesticides to fields under irrigation, where runoff can enter streams, canals, ditches, or lakes containing fish.
- (3) Do not spray if pesticides can directly drift into streams, lakes, rivers, or ponds containing fish.
- (4) Do not wash spray equipment in streams.
- (5) Use an approved back-flow device when filling spray tanks from streams.

TOXICITY TO FISH

The following chemical compounds are known to be toxic to fish:

acrolein, aldrin, antimycin, binapacryl, bromoxnil, captafol, chlorbromuron, chlordane, chlorfenvinphos, clonitralid, Copper Sulphate, DDT, demeton, dicofol, dieldrin, dinitramine, dinoseb, disulfoton, dodemorph (Meltatox), endosulfan, endrin, Ethion, fenitrothion, fenthion, folpet, malathion, maneb, medidathion, methoxychlor, methyl isothiocyanate, methomyl, Omite, oxythioquinox, parathion, Pentac, pentachlorophenol, pentachlorocyclo pentadien, phenmedipham, phorate, plictran, rotenone, sodium chlorate, sulfoxide, TFM, toxaphene, Truban.

TOXICITY TO BIRDS

The following chemical compounds are known to be toxic to birds:

aldicarb, aldrin, arsenicals, azinphos-methyl, carbofuran, chlordane, DDT, demethoate, demeton I and II, diazinon, dieldrin, endosulfan, endrin, ethion, fenaminosulfan, fenitrothion, fenthion, fonofos, methidation, methomyl, methoxychlor, mevinphos, parathion, phosphamidon, propoxur, trichlorfon, Zectran.

TOXICITY TO HONEY BEES

Many pesticides are toxic to honey bees and other beneficial insects. The farmer, bee keeper, and pest control operator must co-operate closely to keep the losses of beneficial insects to a minimum. For the protection of these insects, only the safest materials should be used.

PRECAUTIONS TO BE TAKEN

- (1) Do not apply insecticides while fruit trees are in bloom. It is an offence in Ontario to do so under the Bees Act.

- (2) Use the proper dosage of the safest material that will give good pest control.
- (3) When using materials hazardous to bees, notify the bee-keeper so that he can confine them in the hives.
- (4) Dusts are, as a rule, more hazardous to bees than are sprays.
- (5) Repeated applications cause greater bee losses.
- (6) Treatments when bees are foraging in the field are to be avoided. Applications made in hot weather, when bees are clustering on the outside of the hives for fanning purposes, may cause severe losses. Treatments made during the evening, or early in the morning before bees are foraging, are the safest.
- (7) The drift of hazardous chemicals onto neighbouring fields attractive to bees may cause losses.
- (8) Hives returned to a field after the pesticide treatment usually suffer fewer losses than hives left in the field when it is sprayed.

The following chemical compositions are highly toxic to bees:

acephate (Orthene)	fenitrothion (Sumithion)
aldicarb (Temik)	fensulfothion (Dasanit)
aminocarb (Metacil)	fenthion (Baytex)
azinphos-methyl (Guthion)	Iso-Systox
benzene hexachloride (Lindane)	malathion (Cythion)
carbaryl (Sevin)	methidathion (Supracide)
carbofuran (Furadan)	parathion
chlorpyrifos (Dursban)	phosdrin
dibrom (Naled)	phosmet (Imidan)
dicamba (Diclear)	phosphamidon (Dimercon)
dichlorvos (DDVP, Vapona)	prometone (Primatol)
dicofol (Kelthane)	propoxur (Baygon)
dimethoate (Cygon, Rogor)	TEPP
ethion	tetrachlorvinphos (Gardona)
	Zectran

The following chemical compounds are moderately toxic to bees (they should not be applied when bees are foraging in the field, or at the colonies):

chlordane	perthane
chlordecone (Kepone)	phosalone (Zolone)
crotoxyphos (Ciodrin)	ronnel (Korlan)
demeton (Systox)	temephos (Abate)
disulfoton (Di-Syston)	trichlorfon (Dylox)
endosulfan (Thiodan)	trichloronat (Agritox)
methomyl (Lannate)	trithion
methoxychlor	ziram (Zerlate)
metiram (Polyram)	

The following pages contain tables of LD₅₀ values of pesticides that have been used or are currently being used in Ontario. The data quoted refer to laboratory tests with rats, except where rabbits were used for dermal tests, shown as (Rb). The figures shown should be considered as relative indicators rather than absolute values, as the data quoted originated from many sources.

You must know the common name of the chemical in order to use the tables. The common name is listed on the label and in the study material supplied to you.

RELATIVE TOXICITY OF PESTICIDES

Common Name	Trade Name	LD ₅₀ (mg/kg)		Chemical Group
		Oral	Dermal	
<u>Herbicides</u>				
acrolein	Aqualin	46	562 (Rb)	aldehyde
alachlor	Lasso	1200	3500 (Rb)	acetanilide
allidochlor	Randox	700	360	acetamide
amitrole	Aminotriazole	14,700	>10,000	triazine
ammonium sulfamate	Ammate X	3900		
ametryne	AA top	1405	5600 (Rb)	triazine
asulam	Asulox	>8000	>1200	carbamate
atrazine	AAtrex	3080	7500 (Rb)	triazine
1,2-dimethyl-3,5-diphenyl pyrazolium ion	Avenge	320-450	770 (Rb)	
aziprotryn	Mesoranil	3600	>3000	triazine
barban	Carbyne	600	>1600	carbamate
benazolin	Tricornox	>3000		
benefin	Balan	>800		dinitroaniline
bensulide	Betasan	770	3950	organophosphorus
bentazon	Basagran	1100	2500	diazine
benzoylprop ethyl	Endaven	1555	>1000	
boracic acid		3000		
bromacil	Hyvar	5200	5000 (Rb)	urea
bromoxynil	Buctril	190-270	>3660 (Rb)	nitrile
butylate	Sutan	3997-4659	>2000 (Rb)	carbamate
cacodylic acid	Phytar	830		arsenic
carbutylate	Tandex	3000	>15,400	carbamate

Common Name	Trade Name	LD ₅₀ (mg/kg)		Chemical Group
		Oral	Dermal	
chloramben	Amiben, Vegiben	5620	>3160	benzoic acid
chlorbromuron	Maloran	820	3000	urea
chloropicrin	Picfume	0.8		
chloroxuron	Tenoran	3000	>10,000	urea
chlorpropham	CIPC	5000-7500	10,200 (Rb)	carbamate
chlorthal	Dacthal	>3000	>10,000 (Rb)	phthalic acid
cutrine		8680		copper complex
cyanazine	Bladex	149	>1200	triazine
cycloate	Ro-Neet	2000-3190	2000 (Rb)	carbamate
cyprazine	Outfox	1200+200		triazine
2,4-D amines, salts and acids		300-1000	800-1500	phenoxy
2,4-DB (butyl ester)	Embutox	700-1500	800	phenoxy
dalapon		3860-9000	>2000 (Rb)	propionic acid
desmedipham	Betanol-475	>10,250		carbamate
diallate	Avadex	395	2000-2500 (Rb)	carbamate
dicamba	Banvel	1040	>1000	benzoic acid
dichlobenil	Casoran	2710	1350 (Rb)	nitrile
dichlorfopmethyl (proposed) HOE - Glass		557 - 580	>5000	phenoxy
dichlorprop	2,4-D-P	800		phenoxy
dinitramine	Cobex	3000	>6800 (Rb)	dinitro comp'd.
dinoseb	Premerge	5-60	135-200	dinitro comp'd.
diphenamid	Dymid	1000	6320	acetamide
diquat	Reglone, Aquacide	400-440	>500	pyridylum
disul	2,4-DES	730-1400		phenoxy
diuron	Karmex	3400		urea
disodium methyl arsonate	Ansar 184	600		
EPTC	EPTAM	1630	1460	carbamate
ertom	Baron	1120		phenoxy
endothall	Aquathol, Hydout	38-206	750	phthalic acid
fenuron	Dybar	6400		urea
fenoprop salts and amines	Silvex	500-1000		phenoxy

Common Name	Trade Name	LD ₅₀ (mg/kg)		Chemical Group
		Oral	Dermal	
ferrous sulphate	Green Vitrol	5000		
fenac		1780-3000	> 3160 (Rb)	phenylacetic acid
flamprop-methyl	Metaven	1210	> 2800	amino-propionate
	Hammer (Erbotan)	278	2150	urea
glyphosate	Roundup	4320	> 7940 (Rb)	organophosphate
ioxynil	Totril	110		nitrile
Kerb		5620-8350	> 3160 (Rb)	
	Krenite	10,200	> 1683 (Rb)	carbamate
linuron	Lorox	1500-3000		urea
MCPA (amines, esters and salts)		700-1000	> 1000	phenoxy
MCPB salts	Tropotox	680	1000	phenoxy
mecoprop salts	Compitox	930	900 (Rb)	phenoxy
metam (sodium)	Vapam	97	800 (Rb)	carbamate
metribusan	Sencor	1937-2345		triazine
methyl bromide		1 mg/litre ³		
methyl isothiocyanate	Vorlex	175-300	2780	
metobromuron	Patoran	2000	> 10,000 (Rb)	urea
metolachlor	Primextra	2780	> 3170	acetamide
monolinuron	Afesin, Aresin	2100		urea
monosodium acid methane arsonate	Ansar 170	700-1800		arsenic
monuron	Telvar	3500-3700	> 2500	urea
monuron - TCA	Urox	2300-3700		
naptalam	Dynap	1700-8500		phthalic acid
neburon	Kloben	11,000		urea
nitralin	Planavin	1000-2000	> 2000 (Rb)	dinitroaniline
nitrofen	TOK-E-25	2630-3580		nitrophenyl
paraquat	Gramoxone	157-207	> 480 (Rb)	pyridinium
pebulate	Tillam	921-1120	2936 (Rb)	carbamate
pentachlorophenol	PCP	27-80	150-350	CH
phenmedipham	Betanal	> 8000	> 4000	carbamate
picloram amines and salts	Tordon	3080	> 4000 (Rb)	picolinic acid
prometone	Primatol	2245-2980		triazine

CH - chlorinated hydrocarbon

Common Name	Trade Name	LD ₅₀ (mg/kg)		Chemical Group
		Oral	Dermal	
prometryne	Gesagard	3750	>1000	triazine
propachlor	Ramrod, Ramdox	710		acetanilide
propanil	Stam F-34	560-1384	7080	acetanilide
profluralin	CGA - 10832	2200 (46% E.C.)	>10,250 (46%E.C.)	dinitro aniline
propham	IPC	5000		carbamate
pyrazon	Pyramin	3600		pyridazone
siduron	Tupersan	>5000		urea
simazine	Princep	5000	>8160 (Rb)	triazine
sodium chlorate, mixtures		5000	>10,000	
solan	Pentanochlor	>10,000	10,000 (Rb)	acentanilide
sulfallate	Vegadex, CDEC	850		carbamate
2,4,5-T amines	numerous	300		phenoxy
terbutryn	Topogard	2000-2980	>10,200	triazine
tebuthiuron	Spike, Preflan	596-720		urea
terbacil	Sinbar	>5000	>5000 (Rb)	urea
terbutol	Azak	>10,250	>15,000	carbamate
terbuthylazine	Gerdoprim	2000	4000 (Rb)	carbamate
triallate	Avadex TW	1675-2165	2225 (Rb)	carbamate
trichloroacetic acid	TCA	5000		
trichlorobenzoic acid		750-1000	>1000	benzoic acid
trifluralin	Treflan	3700	>5000	dinitroaniline
vernolate	Vernam	1710	>2995 (Rb)	carbamate
	Velpar	1690	≥5278	triazine
<u>Other Compounds</u>				
alcohol ethoxylate primary		1600	2500 (Rb)	alcohol
acetic acid		3310		
4-aminopyridine	Avitrol	32	327 (Rb)	pyridine
antimycin (fish toxicant)	Fintrol	28		antibiotic
bayluscide 5G (molluscicide)		75		CH
bayluscide TGM WP (sea lamprey larvic)		0.5-1.0		CH

CH - chlorinated hydrocarbon

Common Name	Trade Name	LD ₅₀ (mg/kg)		Chemical Group
		Oral	Dermal	
Biobar, J.F. (bactericide)		3.16	2000 (Rb)	ether
butoxypolypropylene glycol	Crag	11,200		ether
4-chlorophenoxy acetic acid		300-700	1600 (Rb)	phenoxy
chlorflurecol methyl	Chlorflurenol	4300	>1000 (Rb)	CH
chlormequat	Cycocel	670	323 (Rb)	CH
citronyl		7563	2000 (Rb)	
cittowet		3200		
N,N-diethyl-m-toluamide	DEET	2000		
diflubenzuron	Dimilin	>4600	>4000 (Rb)	
dimethyl phthalate	NTM, DMP	7	>4800	dicarboxylate
ethephon	Ethrel		5730 (Rb)	OP
metaldehyde (Slug & Snail Bait)		600		aldehyde
methoprene	Altosid	>34,600	3000-10,000 (Rb)	
	Mitin FF (mothproofing)	750-1300		
2,2-dimethyl hydrazide	Succinic acid	8400	>16,500 (Rb)	
polyvinyl polymer	Nalco-Trol	34,600	2000 (Rb)	
starbar	Alar	>23,070	>2025 (Rb)	
<u>Rodenticides</u>				
alphachloralose		205-400		CH
chlorophacinone	Rozol	2.1	200 (Rb)	indandione
coumefafuryl	Fumarin	200		courmarin
DDT		113	25	CH
diphacinone	Diphacin	3		indandione
gophocide		7.5	25	OP
norbormide	Raticate	5		dicarboximide
pindone	Pival	50		indandione
red squill		0.43		botanical
strychnine	Mouse Tox	1-30		botanical
sulfaquinoxaline	Sulfa Q-20	1000		
thallium sulphate		25		inorganic
warfarin	Vacor	12.3	4000	urea
		58		coumarin
zinc phosphide		40-46		inorganic

CH - chlorinated hydrocarbon

OP - organophosphate

Common Name	Trade Name	LD ₅₀ (mg/kg)		Chemical Group
		Oral	Dermal	
<u>Fungicides</u>				
allyl alcohol	Vinylarbind	64	89 (Rb)	
anilazine	Dyrene	2700		triazine
benomyl	Benlate	>9590		carbamate
binapacryl	Morocide	62-225	720-810 (Rb)	dinitro compound
boracic acid	Boric Acid	3000		
	Busan 72	1590	10,000	benzothiazole
cadmium chloride		88		
captafol	Difolaton	2500-6200	>15,400 (Rb)	CH
cadminate		660		
captan	Orthocide	9000		CH
carboxin	Vitavax	3200	>8000 (Rb)	anilide
chloranil	Spergon	4000		quinone - CH
chloroneb	Tersan Demosan	>10,000	>5000 (Rb)	CH
chloropicrin	Picfume	0.8		
chlorthalonil	Daconil Bravo	>10,000	>10,000 (Rb)	CH
cycloheximide	Acti-dione	1.8-2.5		antibiotic
dazomet	Mylone	500		diazine
dichlone	Phygon	1500		quinone
dichloran	Bortran	4000		aniline
dichlorophen	Antiphen	1200		CH
dinitrophenol		30		dinitro compound
dinocap	Karathane	980	9400 (Rb)	dinitro compound
dinoseb	Premerge	5-60	135-200	dinitro compound
dinitrocresol	DNOC, Sinox	30-65	>600	dinitro compound
dodemorph	Meltatox	4500		
dodine	Cyprex	750	1500 (Rb)	guanidine
fenaminosulf	Dexon	60		
ferbam	Fermate	1000	>1000	carbamate
folpet	Phaltan	>10,000	>22,600 (Rb)	pthalimide
formaldehyde	Formalin	800		aldehyde
glyodin	Crag 341	3170-5770		imidazole
hexachlorobenzene	HCB	>10,000		CH
hexachlorophene	Nabac, Nacap	138-188		CH
mancozeb	Dithane M-45	6750	>1000	carbamate
maneb	Dithane M-22, Manzate	6750	>1000	carbamate

CH - chlorinated hydrocarbon

Common Name	Trade Name	LD ₅₀ (mg/kg)		Chemical Group
		Oral	Dermal	
mercuric chloride		37		
mercurous chloride	Calomel	100		
methyl bromide	Dowfume MC-2	1 mg/litre ³		
methyl isothiocyanate	Vorlex	175	2780	thiocyanate
metiram	Polyram	6400		carbamate
nabam	Dithane D-14	395	>1000	carbamate
oxycarboxin	Plantvox	2000	>16,000	anilide
pentachlorophenol	PCP	125-210	150-350	CH
quintozene	Terrachlor, PCNB	1750-2000		CH
streptomycin	Agri-Mycin	9000	>600	antibiotic
thiabendazole	Mertect	3350		benzimidazole
thiram	Tersan	780		
thiophanate-methyl	Easout	7000	10,000	
triforine	Fungine	>6000	>770 (Rb)	piperazine
	Truban	4700		thiodiazole
zineb	Dithane Z-78	>5200	>1000	carbamate
ziram	Zerlate	1400	>1000	carbamate
<u>Insecticides</u>				
acephate	Orthene	866 - 945	>2000 (Rb)	OPI
acrylonitrile	VCN, Ventex	93		cyanide
aluminum phosphide	Phostoxin	20 (humans)		phosphide
aldrin		38-67	98	CHI
allethrin		680	11,200	botanical
aldicarb	Temik	0.93	3.15	carbamate
aminocarb	Metacil	30	275	carbamate
azinthosmethyl	Guthion	13	220	OPI
axobenzene		1000		
bacillus thuringiensis	Dipel, Thuricide	>15,000		
benzene hexachloride	(γBHC, γHCH, Gammexane)	125		CHI
benzene hexachloride	Lindane	88	1000	CHI
binapacryl	Morocide	62-255	720-810	
bromophos	Nexion	3750	>5000	OPI
calcium cyanide		4		cyanide
carbaryl	Sevin	400-850	>4000	carbamate
carbofuran	Furadan	8-14	>1000	carbamate
carbon bisulphide		16		sulphide

CH - chlorinated hydrocarbon

OPI - organophosphorus insecticide

Common Name	Trade Name	LD ₅₀ (mg/kg)		Chemical Group
		Oral	Dermal	
carbon tetrachloride		5730-9770		CHI
carbophenothion	Trithion	30.0	54	OPI
chlordane		335	840	CHI
chlordecone	Kepone	125	>2000	CHI
chlorfenson	Ovotran	2000		sulphomate
chlorfenvinphos	Birlane, Supona	10-39	31-108	OPI
chlorpyrifos	Dursban, Lorsban	135-163	202	OPI
chlorobenzilate	AKAR	>700	>5000	CHI
coumaphos	Co-Ral	41	860	OPI
crotoxyphos	Ciodrin	74-125	202-375	OPI
crufomate	Ruelene	635	4000	OPI
DDT	DDT	113	25	CHI
demeton	Systox	6.2	14	OPI
diazinon	Basudin	108	455-900	OPI
dichlofenthion	Nemacide	270	6000 (Rb)	OPI
dichlorvos	Vapona, DDVP	80	107	OPI
dicofol	Kelthane	575-1100	1000-1230	CHI
dielldrin		46	90	CHI
dimefox	Terra Sytam	1-2	5	OPI
dimethoate	Cygon, Rogor	215	400	OPI
dimetilon	Snip	50-64	>2000	carbamate
dinitrocresol	DNOC	40-65	>600	dinitro comp'd.
dinocap	Karathane	980	9400 (Rb)	dinitro comp'd.
dinoseb	Premerge	50	135-200	dinitro comp'd.
disulfoton	Di-Syston	6.8	15	OPI
dioxacarb	Famid	156	3000	carbamate
dinitrophenol		30		dinitro comp'd.
endosulfan	Thiodan	43	130	CHI
endrin		18	15	CHI
ethion	Niallate	27	62	OPI
ethylene dibromide	EDB. Bromofume	117-146		
ethylene dichloride		670-890		
fenitrothion	Accothion, Folothion	250	750	OPI
fenson	Murvesco	1300	>2000	CHI
fensulfothion	Dasanit	4.6-10.5	30	OPI
fenthion	Baytex	215	320	OPI

CHI - chlorinated hydrocarbon insecticide

OPI - organophosphorus insecticide

Common Name	Trade Name	LD ₅₀ (mg/kg)		Chemical Group
		Oral	Dermal	
fonofos	Dyfonate	7.9	147	OPI
formetanate hydro-chloride	Carzol	15-26	>5600	carbamate
chlorphenamidine	Fundal, Galecron	340	4000	
heptachlor	Velsicol 104	100	195	CHI
leptophos	Phosvel	42.9	>800 (Rb)	OPI
lethane		91	125 (Rb)	thiocyanate
	Mitin FF	750		urea
malathion	Cythion	1375	>4400	OPI
methidathion	Supracide	25	155	OPI
menazon	Saphos	890	>500 (Rb)	OPI
metam sodium	Vapam	97	800 (Rb)	carbamate
methiocarb	Mesuroil	130 - 135	350 - 400	carbamate
methomyl	Lannate	17 - 26	250	carbamate
methoxychlor	Marlate	6000	>6000	CHI
methyl isothiocyanate	Vorlex	300	2780	thiocyanate
mevinphos	Phosdrin	6.1	4.7	OPI
methamidophos	Monitor	18.9	118 (Rb)	OPI
oxydemeton-methyl	Meta-Systox R	65	250	OPI
oxythioquinox	Morestan	1100	>2000	cyclo comp'd.
naled	Dibrom	430	800	OPI
nicotine		50	140	botanical
naphthalene		2200	>2500	
	Omite	1350-2200	5000	sulphite
pentachlorophenol	PCP	78	150	CHI
paradichlorobenzene	PDB	500		CHI
parathion-ethyl	Thiophos	13	21	OPI
parathion-methyl	Metacide	9	67	OPI
pentachlorocyclopentadien	Pentac	1200	>3160 (Rb)	CHI
perthane		8170		CHI
phorate	Thimet	2	6.2	OPI
phosalone	Zolone	120	390	OPI
phosmet	Imidan	40-300	>1200 (Rb)	OPI

CHI - chlorinated hydrocarbon insecticide OPI - organophosphorus insecticide

Common Name	Trade Name	LD ₅₀ (mg/kg)		Chemical Group
		Oral	Dermal	
phosphamidon	Dimercron	20	530	OPI
pirimicarb	Pirimor	147	>500	carbamate
	Plictran	420	>2000 (Rb)	cyclo. comp'd.
pyrethrins		>1800	1800	botanical product
piperonyl butoxide		7500		ether
propoxur	Baygon	90-128	1000	carbamate
resmethrin		750	3040	botanical product
ronnel	Korlan	1250	2000	OPI
rotenone	Derris	132	940	botanical
ryania		>750	>4000 (Rb)	botanical
sulfotep	Plantfume, Sulfotepp	5	20	OPI
temephos	Abate	1000	4000	OPI
TEPP		1.12	2.4	OPI
tetrachlorvinphos	Gardona	2300	>4000	OPI
tetradifon	Tedion	566	>10,000 (Rb)	CHI
tetramethrin	Neopynamin	>20,000		organic synthetic pyrethrum
isobornyl thiocyno- acetate	Thanite	1603		thiocyanate
toxaphene	Strobane-T	90	1075	CHI
trichlorfon	Dipterex, Dylox	450-630	>2000	OPI
TDE	Rothane	2500	4000 (Rb)	CHI
trichloronate	Agritox R	16-55	300	OPI
thallium sulphate		25		inorganic
	Zectran	15-63	1500	carbamate
	Valone	50		indandione

CHI - chlorinated hydrocarbon insecticide

OPI - organophosphorus insecticide

STORAGE

- (1) Pesticides should always be stored in a cool, dry, locked, well-ventilated area without floor drains.
- (2) Store away from food and drink used for human and animal consumption.
- (3) Herbicides should be stored separately from other types of pesticides to prevent cross-contamination.
- (4) Always store pesticides in their original containers.
- (5) A sign with the words: "Chemical Storage Warning - Authorized Persons only" in block letters clearly visible should be placed on the outside of each entrance leading into the storage area. Protective clothing, a respirator, and a first aid kit should be available in the storage area.

DISPOSAL

All empty containers and unused amounts of pesticides must be securely held in an isolated storage area until they can be disposed of correctly. Immediately after emptying a container, rinse several times with the same diluent as used for mixing. Pour the rinse into the spray tank load. Crush empty pesticide containers and bury under at least 18 inches of soil away from water.

PROTECTIVE CLOTHING AND RESPIRATORS

Proper protective clothing and equipment should always be worn when handling, mixing or applying pesticides. A water repellent hat with a full brim, rubber boots, rubber gloves, coveralls, rubber apron should be worn to protect the skin from exposure to pesticides.

A respirator approved by the United States Bureau of Mines and/or the National Institute for Occupational Safety and Health (NIOSH) should always be worn whenever there is any risk of dust or vapour being inhaled. A respirator should cover at least the mouth and nose and must fit well. Cartridges or cannisters should be changed after about every 8 hours use or sooner if any odour of the material is detected by the operator, once the cannister becomes saturated, it no longer protects the user. A list of approved respirator devices for protection against pesticides can be obtained from the Pesticide Control Specialist, Ministry of the Environment, in your area.

PROTECTION OF THE OPERATOR

Protection against over-exposure of operational personnel to toxic materials depends upon: (1) prevention of accidents, (2) use of protective clothing, and (3) adequate medical resources.

PREVENTION

All personnel should train themselves to observe the following guidelines:

- (1) Open all pesticide containers carefully, and on a stable surface where they won't tip or spill easily.

- (2) Open, pour, and mix in a specific area where no person can be contaminated, and where any spills can be cleaned up properly.
- (3) Use the proper tools to open containers. Use a knife to open paper and plastic bags, and to cut tops. (Don't use a screwdriver or pickaxe, etc., because of the risk of material spurting out onto face and eyes). Ripping open a bag usually causes an uneven tear, thus making spills more likely.
- (4) Stand upwind of all opening, pouring, and mixing operations.
- (5) Open, pour, weigh, and mix in a well-ventilated area.
- (6) Learn how to pour properly from a container. Splashing and spurting can be avoided if a can is held so that the opening is at the top. If an air vent is provided, use it.
- (7) Wear clean and well-fitted goggles or respirator, (or a face shield), rubber gloves, coveralls, rubber boots and apron for protection in the event of a splash or spill - especially when handling concentrated or highly toxic materials.
- (8) Be sure you know where to easily and quickly obtain a good supply of lime, coarse clay, sand, sawdust, or other absorbent to soak up a spilled pesticide.
- (9) Do not permit any person to work alone, especially when handling a highly toxic pesticide.
- (10) A pilot must never take part in mixing and loading operations, and should stand well away.
- (11) Learn to recognize the typical signs and symptoms of pesticide poisoning.
- (12) If you feel ill during pesticide application, or shortly after, stop work and seek medical attention at once. Do not carry on because of the work schedule.
- (13) Never use the mouth to siphon liquid materials or to blow out a clogged spray nozzle.
- (14) Keep all unprotected persons away from any equipment that may be contaminated. Consider all such equipment dangerous until properly decontaminated.
- (15) Remember that equipment used for the application of herbicides should be reserved exclusively for that purpose.

- (16) Make sure that personnel who maintain or clean equipment are aware of the hazards and follow safety procedures similar to those for handling the toxic products themselves. Do not permit anyone unfamiliar with chemical safety practices to carry out cleaning procedures.
- (17) Ensure that smoking, drinking and eating are absolutely prohibited in every chemical handling area.
- (18) Change clothes daily, and more often if any contamination occurs.
- (19) Shower thoroughly, with special attention to hair and fingernails, before going home.
- (20) Never fail to discard leaky gloves or contaminated leather boots or shoes.
- (21) Know the limitations of the protective clothing and equipment, especially which respirator cartridge to use and how often to change it. Remember that each person's protective outfit must be complete.
- (22) Know that a very serious risk is taken if a victim of pesticides poisoning is allowed to drive home unattended. It is simply not possible to judge the ultimate severity by the initial symptoms. A severe poisoning may seem quite mild at the outset. Once poisoning is suspected, someone should stay with the patient until he reaches medical treatment, and he certainly should not operate a vehicle.
- (23) Be certain to read the label of every pesticide used. These are carefully prepared and carry the necessary information respecting rates, uses, cautions, and hazards. If a label is damaged or illegible, do not use that material. Be sure you know the chemical being used.
- (24) Make sure that the aircraft tank or hopper openings are securely closed.
- (25) Make sure that water, soap and towels are available at the loading site.

DRIFT OF PESTICIDES

A basic principle of pest control is the application of a pesticide to the host plant, host area or directly on the pest to control undesirable insects, plants, fungi, or diseases. The safe and efficient use of pesticides necessitates that pesticides land on the target area. The portion of the spray that drifts may lead to erratic pest control within the target area or environmental problems.

WHAT IS DRIFT?

Drift is the movement of particles or droplets off of the target. There are two types of drift - vapour drift and spray drift:

Vapour Drift: is the movement of vapour which results from volatilization or evaporation of the pesticide. The evaporation may occur from the droplets at the time of application or from the pesticide deposited on the plants or surrounding soil surface after the application.

Spray Drift: is the movement of droplets of pesticide from the target during the application because of wind, air currents or other factors. The larger droplets are moved only a short distance but small particles may remain suspended on air currents and can be deposited at a distant point.

WHAT FACTORS AFFECT DRIFT?

The factors which cause drift are very complex and involve the interrelationship of such factors as wind velocity, air pressure, temperature, height of the spray nozzles and size of the holes in the nozzle head.

1. Wind: If the wind speed is greater than 7 m.p.h. some of the spray may drift away from the target area.
2. Droplet Size: As the spray droplet size becomes smaller, drift is more likely to occur. The droplet size can be altered by the choice of spray nozzle on the equipment and the pressure at which the pesticide is applied. Generally, higher pressure produces finer droplets which are more likely to drift.
3. Temperature: With warmer temperatures, evaporation of the spray increases; thereby, increasing the possibility of vapour drift.
4. Distance Between Nozzle and Target Area: As the distance between the nozzles and the target increases, the possibility of drift increases.

The pesticide spray applied should land on the target. However, it could land in the target area but not on the target; it could drift

outside the target area, of after application, pesticide could drift through evaporation. Several problems should be considered:

1. Adjacent Crop Damage: When spraying the target area, drift can damage susceptible crops. This is a consideration when using herbicides; for example, a herbicide for broad-leaved weeds will also destroy such crops as tomato, soya bean, and grapes. As well as crop damage, drifting pesticide can contaminate crops ready for harvest, leaving unacceptably high residues on the produce.
2. Water Contamination: When drift occurs onto ponds, streams or other bodies there may be a resulting taste or odour. Also, this contamination could be a source of future crop damage if the water is used for irrigation purposes or result in a fish kill.
3. Improper Pesticide Application: This may endanger pollinating insects, animals or humans. Special consideration should be given to the safety of the applicator.
4. Improper Pesticide Levels: If drift occurs to a non-target area, the amount of pesticide applied to the target area is reduced below the recommended quantity and may not be effective.

OPERATIONAL TECHNIQUES WHICH WILL REDUCE DRIFT

1. Spray when the wind is less than 7 miles per hour. (Pay special attention to the label for particular weather conditions).
2. Use nozzles that apply higher gallonage. This helps to reduce drift within the limitations of the machine. Keep nozzles and pressure equipment clean and in good repair.
3. Use the nozzle-type which will give larger droplet size and reduce the distance between the nozzle and the target when spraying.
4. Do not use high pressure pumps in the spray equipment because smaller droplets will be produced, increasing the chance of drift.
5. Consider a less volatile material near susceptible crops to decrease vapour drift. Since water based chemicals evaporate faster than oil based chemicals, special consideration should be given to the oil based material near susceptible crops. In this case, special thickening agents could be used, especially when using herbicides. Also, the same pesticide may be available in several chemical forms which vary in volatility - for example, 2,4-D ester is more volatile than 2,4-D amine. Follow methods of application on the labels.
6. Other formulations and techniques may be as effective. A granular formulation applied to the target may produce the same result as a liquid but reduce chances of drift. As well, mechanical removal of some pests such as brush, may reduce or eliminate the need to use a pesticide.
7. Follow methods of application on the label.

DECONTAMINATION OF APPLICATION EQUIPMENT

The decontamination of tanks, booms, and nozzles is very important. Equipment should be decontaminated when pesticide changes are made and at the end of a season. Many cases of poisoning and damage to crops have occurred from contaminated equipment. Never mix insecticides and herbicides in the same tank or apply them from the same equipment.

Dilute the chemical with lots of water being careful where the wash water drains. Most pesticides degrade in an acid or alkaline medium. The following groups of chemicals should be treated as follows:

(a) Organophosphates

Guthion, diazinon, Cygon, Baytex, malathion, naled, parathion, Abate, Dursban, Dylox, etc.

A solution of washing soda and "javex" will remove organophosphate residues. Care must be taken in using strong solutions, and they should be followed by at least two washings with clean water.

(b) Chlorinated Hydrocarbons

aldrin, chlordane, DDT, Kelthane, endosulfan, endrin, methoxychlor, lindane, etc.

Contact the chemical supplier for specific directions regarding the best procedure to be followed. Chemicals frequently recommended for such use are household ammonia, washing soda, or activated charcoal. Some equipment may be subject to corrosion if exposed to strong alkali or acid. Rinse thoroughly as soon as possible and run lots of clear water through the lines and nozzles.

(c) Carbamates

Baygon, Zectran, Lannate, Maneb, Sevin, carbofuran, etc.

Use a solution of washing soda, or a strong soap solution, and follow with clear water.

(d) Chlorophenoxy Compounds

After the use of herbicides such as 2,4-D or 2,4,5-T, it is necessary to remove the chemical completely from the system, to prevent contamination of the next charge of spray and thus damage to crops. However, complete decontamination is generally considered impossible for these compounds. If the same equipment must be used for the application of

other chemicals, the following methods for "cleaning" are offered:

For either soil or water-soluble solutions:

- (i) Add 1 ounce of activated charcoal and 1 ounce of detergent to each 2 gallons of water. Shake well and discharge through the nozzles, or,
- (ii) Add 10 ounces of lye to 2 gallons of water and allow to stand at least 2 hours. Then discharge through the nozzles and rinse the system twice with clean water.

For water-soluble solutions only:

- (iii) Add $1\frac{1}{2}$ ounces of washing soda to each 2 gallons of water and proceed as in (ii).
- (iv) Add $\frac{1}{2}$ cup of household ammonia to each 2 gallons of water. Flush some through the nozzles and leave the rest in the tank overnight. Then discharge and thoroughly rinse the system with water.

For oil-soluble formulations only:

- (v) Add $1\frac{1}{2}$ cups of kerosene, $1\frac{1}{2}$ ounces of washing soda, and a little detergent to each 2 gallons of water, and proceed as in (ii).

SYMPTOMS AND NOTES
ON
TREATMENT FOR
MAJOR CHEMICAL GROUPS

INSECTICIDES

CHLORINATED HYDROCARBONS

COMMON NAMES: aldrin, chlordane, chlorodecone (Kepone), DDT, dicofol
 (Kelthane), dieldrin, endosulfan (Thiodan), methoxychlor, etc.

PHARMACOLOGIC Neurotoxic CNS, Kidney, Liver
ACTION OR SITE OF
TOXICITY:

ROUTES OF Ingestion, Dermal
ABSORPTION: Inhalation,

TOXICITY: Low to Highly Toxic

SYMPTOMS: Mild exposure, headache, fatigue, loss of appetite, nausea,
 vomiting, fatigue, serious intoxication, trembling, convulsions,
 coma, respiratory failure, death.

FIRST AID: See page #3.
 1. Gastric lavage with 2-4 litres tap water.
TREATMENT 2. Scrub skin with soap and water to decontaminate skin.
BY 3. Barbiturates in appropriate dosages repeated as necessary
PHYSICIANS for restlessness or convulsions.
 4. Artificial respiration with oxygen if breathing is slowed.
 5. Do not induce emesis if the ingested poison is principally
 a hydrocarbon solvent (eg., kerosene, toluene, or other
 petroleum derivatives).

ORGANOPHOSPHORUS COMPOUNDS

COMMON NAMES: abate, azinphosmethyl (Guthion), phosmet (Imidan), chlorpyrifos
 (Dursban), demeton (Systox), diazinon, etc.

PHARMACOLOGIC Anticholinesterase
ACTION OR SITE OF (Irreversible)
TOXICITY:

ROUTES OF Ingestion, Inhalation, Dermal
ABSORPTION:

TOXICITY: Low to Highly Toxic

SYMPTOMS: 1. MILD - anorexia, headache, dizziness, weakness, anxiety,
 tremors of tongue and eyelids, miosis, impairment of visual
 acuity. 2. MODERATE - nausea, salivation, abdominal cramps,
 vomiting, sweating, slow pulse, muscular tremors. 3. SEVERE -
 diarrhea, pinpoint and non-reactive pupils, respiratory
 difficulty, pulmonary edema, cyanosis, loss of sphincter
 control, convulsions, coma, and heart block.

FIRST-AID: (page #3) SPEED IS IMPERATIVE. (1) For extreme symptoms of O.P. poisoning,
TREATMENT
BY PHYSICIANS

(continued)

FIRST AID: (See page #3)

TREATMENT BY PHYSICIANS: inject massive doses of atropine I.V. (2 to 4 mg or 1/30 to 1/15 grain) every 5 - 10 minutes until signs of atropinization occur. A total of 25 to 50 minutes until signs of atropinization may be necessary during the first day. Watch for reduction in salivation. Do not give atropine to a cyanotic patient. Give artificial respiration first then administer atropine. Oral atropine is never used and atropine prophylaxis is not recommended. (2) 2-PAM (Protopam chloride), 1 gm I.V. slowly over a period of 5 minutes. Give a second dose of 500 mg. in 30 minutes if muscle weakness persists. (3) Avoid morphine, theophyllin, aminophyllin, barbiturates, or phenothiazines.

CARBAMATES

COMMON NAMES: aldicarb (Temik), carbaryl (Sevin), carbofuran (Furadan), methomyl (Lannate).

PHARMACOLOGIC ACTION OR SITE OF TOXICITY: Anticholinesterase (Reversible)

ROUTES OF ABSORPTION: Ingestion, Inhalation, Dermal

TOXICITY: Low to Highly Toxic

SYMPTOMS: Constriction of pupils, salivation, profuse sweating, lassitude, muscle incoordination, nausea, vomiting, diarrhea, epigastric pain, tightness in chest.

FIRST AID: (see Page 3)

TREATMENT BY PHYSICIANS: SPEED IS IMPERATIVE. (1) For extreme symptoms, inject massive doses of atropine I.V. (2 to 4 mg. or 1/30 to 1/15 grain) every 5-10 minutes until signs of atropinization occur. A total of 25 to 50 mg. may be necessary during the first day. Watch for reduction in salivation. (2) Morphine may be given if needed. Avoid theophyllin, aminophyllin, or barbiturates. 2-PAM is not indicated. Oral Atropine is never used, and Atropine prophylaxis is not recommended. (3) Draw blood for cholinesterase test.

FUMIGANTS

HALOGEN FUMIGANTS

COMMON NAMES: Methyl Bromide

PHARMACOLOGIC ACTION OR SITE OF TOXICITY: Kidney, CNS depressant

ROUTES OF ABSORPTION: Ingestion, Dermal
Inhalation,

TOXICITY: Highly Toxic

SYMPTOMS: Appears after four to twelve hours following inhalation. Symptoms include dizziness, headache, anorexia, nausea, vomiting, and abdominal pain. Lassitude, weakness, slurring speech and staggering gait. Mental confusion, mania, tremors and epileptiform convulsions. Bromides cause: rapid respiration, pulmonary edema, cyanosis, collapse, and death. Coma, areflexia, and death due to respiratory or circulatory failure. Late manifestations may include bronchopneumonia, pulmonary edema, and respiratory failure. Methyl bromide may produce cutaneous blisters and kill via dermal exposure.

TREATMENT BY PHYSICIANS: dimercaprol (for first aid treatment, see page #3)

CYANIDE FUMIGANTS

COMMON NAMES: acrylonitrile (organic bound cyanides), calcium cyanide (cyanogas), hydrogen cyanide (Hydrocyanic acid).

PHARMACOLOGIC ACTION OR SITE OF TOXICITY: Cell metabolism

ROUTES OF ABSORPTION: Ingestion,
Inhalation

TOXICITY: Highly Toxic.

SYMPTOMS: One of fastest acting known poisons. Massive dose: unconsciousness and death without warning. Smaller doses - illness may last one or more hours. Following ingestion, bitter, acrid, burning taste followed by constriction of membrane in throat. Salivation and nausea without vomiting. Anxiety, confusion, and dizziness. Variable respirations - inspiration short and expiration prolonged. Odour of bitter almonds in breath and vomitus. Initial increase in blood pressure and slowing of heart followed by rapid and irregular pulse, palpitation, and constriction of chest. Unconsciousness, convulsions, and death from respiratory failure.

FIRST AID: (see page 3)

TREATMENT BY PHYSICIANS: SPEED IS IMPERATIVE. (1) If apneic, start artificial respiration. Keep airway open. (2) Inhalation of amyl nitrite (amyl nitrite perles) every 15-30 seconds while 3% sodium nitrite solution is being prepared. (3) Intravenous injection (even of nonsterile solution) of 10 ml of 3% sodium nitrite over 2-4 minute period. Do not remove needle. (4) Through same needle give 50 ml of 25% solution of sodium thiosulfate over 10 minutes. (5) If symptoms recur, repeat the nitrite and thiosulfate. (6) Stomach lavage with 1:5000 potassium permanganate should follow the above procedure. (7) Oxygen therapy and whole blood transfusions may be necessary if nitrite induced methoglobinemia becomes severe.

PHOSPHINE FUMIGANTS

COMMON NAMES: aluminum phosphide

PHARAMACOLOGIC lungs
ACTION OR SITE
OF TOXICITY:

ROUTES OF Inhalation
ABSORPTION:

TOXICITY: Highly Toxic

SYMPTOMS: Nausea, vomiting, diarrhea, great thirst, headache, vertigo, tinnitus, pressure in chest, back pains, dyspnea, a feeling of coldness, and stupor or attacks of fainting. May develop hemolytic icterus and cough with sputum of a green fluorescent colour. Chronic poisoning may be characterized by anemia, bronchitis, gastrointestinal disturbances, dental necroses, and disturbances of vision, speech, and motor functions.

FIRST AID: (see page #3)
 No specific antidote. Keep patient quiet and warm. May need to
TREATMENT treat incipient pulmonary edema with venesection, oxygen, and
BY hypertonic glucose (50%) infusions. Intravenous isotonic solutions
PHYSICIANS: are contraindicated.

RODENTICIDES

COUMARINS, INDANDIONES

COMMON NAMES: diphacinone (Diphacin), fumarin, Pival (Pivalyn), PMP (Valone), Warfarin.

PHARAMACOLOGIC Anticoagulant
ACTION OR SITE
OF TOXICITY:

ROUTES OF Ingestion
ABSORPTION:

TOXICITY: Low (single dose) to Highly Toxic -
 (Multiple Doses).

SYMPTOMS: After repeated ingestion for several days: Bleeding from nose, gums, and into conjunctiva, urine, and stool. Possible pallor and petechial rash. Hemorrhages in organs, widespread bruising, and bleeding into joint spaces, shock, and death.

FIRST-AID (see Page 3) (1) Lavage stomach with tap water.
TREATMENT (2) Vitamin K (mephyton or menadione preparation) by mouth.
BY intramuscularly or intravenously. Vitamin C may be a
PHYSICIANS: useful adjunct.
(3) Transfuse with fresh blood if bleeding is severe or until
anemia is corrected.
(4) Iron (ferrous sulfate) by mouth for correction of secondary
anemia, 0.3 gm. t.i.d.

HERBICIDES

ORGANIC ACIDS AND DERIVATIVES

COMMON NAMES: Cacodylic acid, dichlorophenoxyacetic acid (2, 4-D), silvex
(2,4,5-TP), trichlorophenoxyacetic acid (2,4,5-T).

PHARAMACOLOGIC Liver
ACTION OR SITE Kidney
OF TOXICITY:

ROUTES OF Ingestion,
ABSORPTION: Dermal

TOXICITY: Low toxicity.

SYMPTOMS: Weakness, and perhaps lethargy. Anorexia, diarrhea. Muscle
weakness, may involve the muscles of mastication and swallowing.
Ventricular fibrillation and/or cardiac arrest and death.

FIRST-AID: (see page (1) For ingestion, lavage stomach with tap water. For skin
TREATMENT #3) contact, wash exposed area.
BY PHYSICIANS: (2) Supportive treatment.
(3) Quinidine sulfate or quinine to relieve myotonia or suppress
abnormal ventricular cardiac rhythm.

UREAS

COMMON NAMES: Bensulide (Betasan), bromacil (Hyvar-X), diuron (Karmex),
Fenuron - TCA, Monuron (Telvar).

PHARAMACOLOGIC Respiratory
ACTION OR SITE
OF TOXICITY:

ROUTES OF Ingestion
ABSORPTION:

TOXICITY: Low toxicity.

MISCELLANEOUS (Herbicides)

COMMON NAMES: Diquat (pyridylum), Endothall (Dicarboxylic acid derivative), Paraquat (quarternary ammonia derivative).

PHARAMACOLOGIC ACTION OR SITE OF TOXICITY: CNS, Lungs, Eyes.

ROUTES OF ABSORPTION: Ingestion, Inhalation.

TOXICITY: Low to Highly Toxic.

SYMPTOMS: May cause lethargy, convulsions, coma.

FIRST-AID: (see page 3) (1) Lavage and catharsis.
TREATMENT (2) May need artificial respiration.
BY PHYSICIANS: (3) Barbiturates for convulsions.

SOLVENTS

HYDROCARBONS

COMMON NAMES: Petroleum products including: diesel oil, kerosenes, gasoline, xylene.

PHARAMACOLOGIC ACTION OR SITE OF TOXICITY: CNS, Lung, Kidney, Liver.

ROUTES OF ABSORPTION: Ingestion

TOXICITY: Low toxicity.

SYMPTOMS: Nausea, vomiting, cough and pulmonary irritation progressing to pulmonary edema, bloody sputum, and bronchopneumonia. Heavy ingestion can cause symptoms of depression or irritation, including coma and convulsions.

FIRST AID: (see page #3)

TREATMENT BY PHYSICIANS: NO EMETICS. Use care to prevent aspiration. To dissolve kerosene, and slow absorption, give 250 ml. (8 oz.) of liquid petrolatum orally. Follow with saline cathartic. Use gastric lavage if more than 4 mg/kg. ($\frac{1}{2}$ pint/150 lb.) has been ingested. Remove patient to fresh air. Oxygen and corticosteroids may be needed in severe cases. Antibiotics are sometimes indicated.

POISON CONTROL CENTRES IN ONTARIO

BARRIE

Royal Victoria Hospital
Emergency Department
(705) 728-9802

BELLEVILLE

Belleville General Hospital
Emergency Department
(613) 968-5511

BRANTFORD

Brantford General Hospital
Dr. C. H. Pickett
(519) 752-7871

St. Joseph's Hospital
Dr. D. Swan
(519) 753-8641

BURLINGTON

Joseph Brant Memorial Hospital
Dr. D. Raes
(416) 624-1080

CHATHAM

St. Joseph's Hospital
Emergency Department
(519) 352-2500

GUELPH

St. Joseph's Hospital
Dr. J. J. Brown
(519) 824-2620

HAILEYBURY

Temiskaming Hospital
Director
(705) 672-3314

KAPUSKASING

Sensenbrenner Hospital
Emergency Department
(705) 335-6041

KINGSTON

Kingston General Hospital
Dr. C. J. Padfield
(613) 547-2001

KIRKLAND LAKE

Kirkland and District Hospital
Director
(705) 567-5251

KITCHENER

Kitchener-Waterloo Hospital
Dr. Swan
(519) 742-3611

St. Mary's General Hospital
Dr. W. H. Friday
(519) 744-3311

LONDON

Victoria Hospital
Emergency Department
(519) 432-5241

OTTAWA

Children's Hospital
Emergency Department
(613) 521-4040

Ottawa General Hospital
Emergency Department
(613) 231-2121

PICTON

Prince Edward County Memorial Hospital
Emergency Department
(613) 476-2181

ST. CATHARINES

St. Catharines General Hospital
Dr. W. G. Sollich
Emergency Department
(416) 684-7271

SARNIA

Sarnia General Hospital
Dr. C. Sorensen
Emergency Department
(519) 344-3661

SAULT STE. MARIE

Plummer Memorial Public Hospital
Emergency Department
(705) 254-5161

SIMCOE

Norfolk General Hospital
Dr. K. R. McGavin
(519) 426-0750

SUDBURY

Sudbury General Hospital
Dr. E. S. Lapchinski
(705) 674-3181

THUNDER BAY

McKellar General Hospital
Dr. G. F. Rogan
(807) 623-5561

Port Arthur General Hospital
Dr. Arnot R. Hawkins
(807) 344-6621

TORONTO

Toronto East General and
Orthopedic Hospital
Dr. Donald Price
(416) 461-8272

Hospital for Sick Children
Dr. Raymond Ng
(416) 597-1500

WINDSOR

Hotel Dieu de St. Joseph
Emergency Department
(519) 252-3631

WEIGHTS AND MEASURES

- 1 imperial gallon = 4 quarts = 8 pints = 160 fluid ounces
= approximately 1.2 U.S. gallons
- 1 U.S. gallon = .8345 or approximately 5/6 imperial gallon
- 1 imperial gallon of water weighs 10 pounds
- 1 imperial quart = 2 pints = 40 fluid ounces
- 1 imperial pint = 20 fluid ounces = 2½ cups
- 1 measuring cup = 8 fluid ounces
- 3 teaspoons = 1 tablespoon = ½ fluid ounce
- 1 ton = 2,000 pounds
- 1 pound = 16 ounces
- 1 ppm = one part per million by weight
= 1 pound in 100,000 gallons of water
- 100 ppm = 1 pound in 1,000 gallons of water
= 1.6 ounces in 100 gallons of water
- 1:1000 by weight: means 1 part of material by weight in 1,000 parts of another by weight.
- eg., 1 ounce of copper sulfate in 1,000 ounces of water (=25 quarts = 6¼ gallons of water).
- eg., 1 gram of copper sulfate in 1 litre of water.
- 1 ounce per 1,000 square feet is approximately 3 pounds per acre.
- 1 pint = 20 fluid ounces of spray mixture per 1,000 square feet = the 5 gallons per acre rate.
- To convert Imperial gallons to U.S. gallons, multiply by 1.2
- To convert U.S. gallons to Imperial gallons, multiply by 0.8345 (or .83)

- 1 mile = 5,280 feet = 1,760 yards = 320 rods
- 1 rod = 16.5 feet = 5.5 yards
- 1 yard = 3 feet = 36 inches
- 1 foot = 12 inches
- 1 acre = 43,560 square feet = 4,840 square yards
= 160 square rods
- 1 square yard = 9 square feet
- 1 mile an hour = 88 feet a minute
- 1 square foot = 144 square inches
- 1 rod x 1 mile = 2 acres.

METRIC EQUIVALENTS

LENGTH

inch = 2.54 cm
foot = 0.3048 m
yard = 0.914 m
mile = 1.609 km

millimetre = 0.039 in.
centimeter = 0.394 in.
decimetre = 3.937 in.
metre = 3.28 ft
kilometre = 0.621 mile

AREA

square inch = 6.452 cm²
square foot = 0.093 m²
square yard = 0.836 m²
square mile = 2.59 km²
acre = 0.405 ha

Metrification of pesticide labels will take place between January 1, 1977 and January 1, 1979.

AREA

cm² = 0.155 square inches
m² = 1.196 square yards
km² = 0.386 square miles
ha = 2.471 acres

VOLUME (dry)

cubic inch = 16.387 cm ³	cm ³ = 0.061 cubic inches
cubic foot = 0.028 m ³	m ³ = 31.338 cubic feet
cubic yard = 0.765 m ³	hectolitre = 2.8 bushels
bushel = 36.368 litres	m ³ = 1.308 cubic yards
board foot = 0.0024 m ³	

VOLUME (liquid)

fluid ounce (Imp) = 28.412 ml	litre = 35.2 fluid ounces (Imp)
pint = 0.568 litre	hectolitre = 26.418 gal (U.S.)
gallon (Imp) = 4.546 litres	= 21.997 gal (Imp)

WEIGHT

ounce = 28.349 g	gram = 0.035 oz.
pound = 453.592 g	kilogram = 2.205 lb
hundredweight (Imp) 45.359 kg	tonne = 1.102 short ton
ton = 0.907 tonne	

PROPORTION

1 gal/acre = 11.234 litres/ha	1 litre/ha = 14.24 fluid oz/acre
1 lb/acre = 1.120 kg/ha	1 kg/ha = 14.5 oz. avdp/acre
1 lb/sq in = 6,895 kilo Pascals (KPa)	1 kg/ha = 0.89 lbs/acre
	1 metric tonne/ha = 0.45 ton/acre
	1 ton/acre = 2.24 metric tonne/ha